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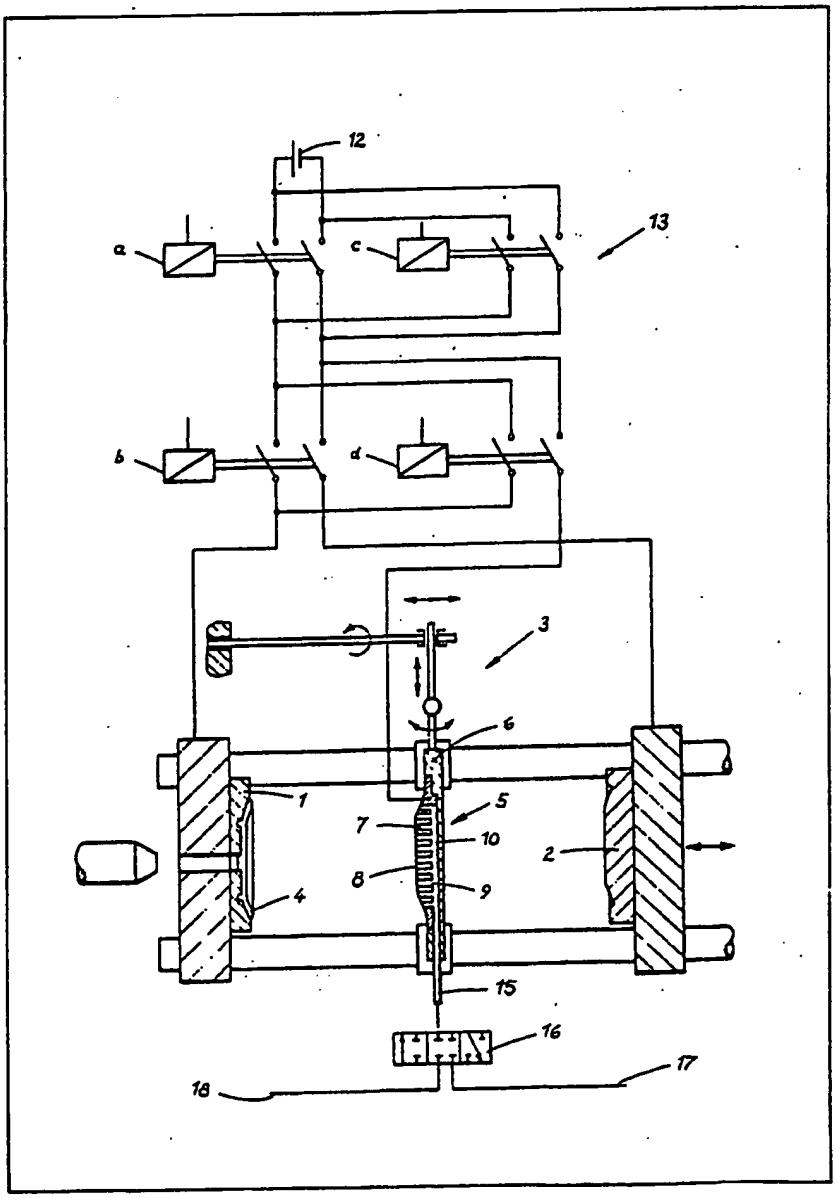
(54) Removal of ceramic mouldings from an injection moulding machine

(57) The invention relates to a device for removing mouldings of a ceramic material from the mould of an injection moulding machine. In order not to damage the mouldings, which are very sensitive because of the water content of the ceramic composition, the device possesses a gripper which has a contact surface 8 shaped to engage the moulding 4, and which is air-permeable and electrically conductive. In use, suction is applied for removal and a direct-voltage source is applied across the contact surface and the mould half of the open mould in which the moulding is held and the electrophoresis effect allows easy release of the moulding.



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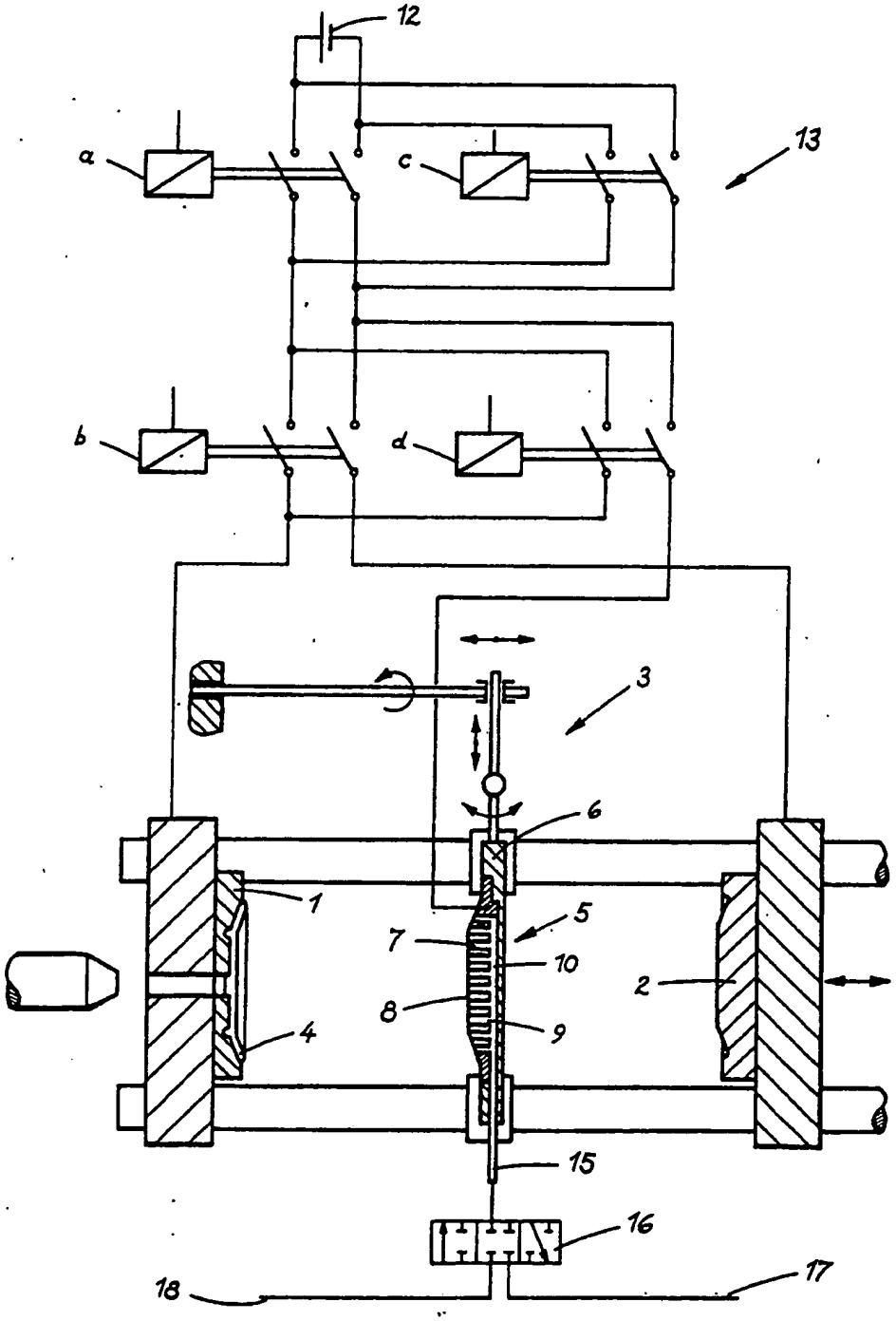
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SPECIFICATION

Removal of ceramic mouldings from an injection moulding machine

The invention relates to the removal of ceramic mouldings from an injection moulding machine.

It is known to manufacture ceramic mouldings, for example plates made from earthenware or porcelain, by injecting an aqueous ceramic composition into the mould cavity of an injection mould. Mouldings manufactured in this way are sensitive to deformation, after the actual injection process, the sensitivity depending on their water content and, naturally increasing with increasing water content. Injection moulding processes for the manufacture of ceramic mouldings are already known, in which the water content of the mouldings is reduced, whilst the mouldings are still in the mould, by suction draining, and it has also been proposed to process ceramic compositions which, *a priori*, have such a low water content that the mouldings are in a self supporting state when removed from the mould. Nevertheless the mouldings, even in this state, must be handled extremely carefully to avoid damage due to exertion of pressure. For this reason it is known to remove the mouldings from the opened mould of an injection moulding machine by means of mechanical devices employing a movable gripper movable to engage the moulding when held in one half of the opened mould. However, the known devices of this type do not make it possible to grip more sensitive mouldings, and to pull them off the mould half to which they adhere, in such a way that damage can reliably be ruled out.

It is therefore the object of the invention to provide a device for removing ceramic mouldings with less risk of damage.

According to the invention, there is provided a device for removing ceramic mouldings from an injection moulding machine having two mould halves, such device comprising a gripper and means to move the gripper to and from a position in which it can engage a moulding held in one of the mould halves when the mould is opened, the gripper having an air permeable contact surface of an electrically conductive material shaped matchingly to engage at least part of the exposed surface of such a moulding, and including means to apply suction through the contact surface and means to connect a direct voltage source across the contact surface and said one mould half.

As a result of the fact that the gripper has a contact surface the shape of which matches the moulding to be removed, the latter can be held in what is in effect a shaping device until it is finally set down. In this operation, no fingers or the like which grip the moulding laterally by its edges and which might leave impression marks are necessary, because suction can be applied, through the contact surface, in the zone of the gripper which matches the shape of the moulding, the moulding thereby being sucked against the contact surface. However, this suction alone might not be able entirely to exclude the danger of damage, particularly with thin-walled ceramic mouldings, because the mouldings, due to their strong cling to the mould half, may under certain circumstances be only partially pulled off the latter, and tear. However, because of its electrical conductivity, the contact surface can be utilised as an electrode for carrying out electrophoresis, the polarity of the direct-voltage source being chosen so as to result in satisfactory and easy release of the moulding from the mould half. Advantageously the mould release of a finished injection moulding is carried out by first connecting opposite poles of the direct-voltage source to the two mould halves while closed, but electrically insulated from one another, so that the moulding is rapidly and easily released by means of electrophoresis from the metallic surface of one mould half. After the subsequent opening of the mould, the moulding still adheres firmly to the other mould half but is freely accessible from one side, so that by means of the actuating mechanism the gripper can be centered with respect to the moulding, and brought into contact with the moulding. The gripper is now connected to a vacuum device by means of an appropriate connection, so that the moulding is sucked against the contact surface of the gripper, since the latter is air-permable. Simultaneously, or subsequently, the polarity of the electrical connection between the direct-voltage source and the mould halves is reversed, and what was the connection to the now empty mould half is made with the contact surface of the gripper, so that the resulting electrophoresis effect causes the moulding to be released from the other mould half. The gripper can be moved away from the second mould half, by means of the appropriate mechanism, after only a few hundredths of a second, with the moulding held against the contact surface by suction and to a slight extent also due to the electrophoresis effect. The moulding can now be carried by means of the gripper to a set-down point, where it can continue to dry. The moulding is released from the gripper by releasing the suction.

It is also conceivable to accelerate the setting-down process by connecting the gripper to a source of compressed air. This actively forces the moulding off the contact surface at the appropriate time and the compressed air flowing through the pores or holes of the contact surface removes any small residues of ceramic composition which may have remained behind.

Since the holding action of the gripper of the device according to the invention is so pronounced, it is possible to move the gripper into any position without there being much danger of the moulding dropping off. For this reason it is possible to use the horizontal arrangement of conventional injection moulding machines for processing plastics even when processing ceramic compositions. Moreover, mouldings of unusually high water content can be safely handled with the device of the invention.

The electrically conductive and air-permeable contact surface of the gripper can take various forms. It is possible, for example, to produce at least one part which defines the contact surface of the gripper from a metallic sintered material, the porosity of this sintered material providing the requisite

air permeability. However, the contact surface can also be formed by a perforated metal plate, which may for example be deep-drawn, and which is sealed at the edges and covers a space in the gripper which communicates with a suction connection. It is also conceivable to provide the gripper, which otherwise consists of a porous or perforated plastics, with a metal layer on its contact surface by electroplating, this layer to be electrically connected to the direct-voltage source.

In order to be able to suit the device according to the invention to different mouldings it is advantageous for a part, which forms the contact surface, of the gripper to be replaceable on a body of the gripper. The gripper body can possess plug-in contacts for the electrical connection and the suction connection, which contacts automatically produce a connection when a suitable part which carries a contact surface is inserted. As a result, the insulating measures required on the device are confined to insulating the insert from the gripper.

In order that the invention may be more clearly understood, the following description is given, by way of example only, with reference to the accompanying drawings in which the sole Figure shows schematically one form of device according to the invention.

In the Figure, numerals 1 and 2 designate the two mould halves of the mould of an injection moulding machine, in the opened state. The remaining parts of the injection moulding machine, on which the mould halves 1, 2 are mounted, are not shown in detail. The device according to the invention, designated 3 in its entirety, for removing a ceramic moulding 4 from the opened mould is also shown only schematically in respect of its mechanism for moving and positioning a gripper 5. The arrows show the degrees of freedom with which the gripper 5 can be moved by the mechanism in order to allow it to be introduced satisfactorily between the mould halves 1, 2 and also to be centered relative to the moulding 4. It is obvious that the mobility of the gripper 5 also makes it possible to set down the moulding 4, after it has been removed, on a drying table or conveyor belt, which is not shown in the drawing.

The gripper 5, shown in cross-section in the drawing, comprises a gripper body 6 and an insert 7, which possesses a contact surface 8. The gripper body 6 consists of any suitable material whilst the insert 7 is electrically conductive, at least at the contact surface 8. Furthermore, the insert 7 is air permeable, this being indicated by channels 9 in the drawing. The channels 9 can be taken to represent perforations but could alternatively represent, for example, porosity in a metallic sintered material. The insert 7 is inserted, in the illustrative embodiment shown, into a corresponding recess of the gripper body 6 in such a way that it closes, in an air-tight manner, a space 10 provided in the said body, with the exception of course of the channels 9. Furthermore, the insert 7 is electrically insulated from the gripper body 6 either by appropriate selection of the materials used or by separate insulating measures.

As can be seen from the drawing, the contact surface 8 of the insert 7 exactly matches the exposed side of the moulding 4 which sticks in the mould half 1, having been released from the mould half 2 on mould opening.

An electrical direct-voltage source 12 is connected via change-over switch 13 to the mould halves 1, 2 and to the contact surface 8 of the insert 7. The connection is engaged so that one pole of the voltage source 12 is connected to one mould half whilst the other pole is connected to the other mould half or to the contact surface 8. During the removal process, the mould half from which the moulding 4 is detached on opening the mould, i.e. the half 2 in the illustration, is not thereafter connected to the source 12, but the contact surface 8 is instead.

By means of the change-over switch 13 it is possible to reverse the allocation of the poles on the one hand to the one mould half (1 as illustrated) and on the other hand to the other mould half (2) and the contact surface (8).

The space 10 in the gripper 5 which is covered by the insert 7 is connected, via a connection line 15 and a change-over valve 16, alternatively to a vacuum device 17 or to a source of compressed air 18. The change-over valve also provides a neutral intermediate position in which the space 10 is subjected to atmospheric pressure. Of course the connecting line 15 is attached to the gripper 5, and can, if appropriate be integrated into its actuating mechanism in such a way that it does not hinder the movements of the gripper 5. This applies analogously to the electrical connections to the voltage source 12.

The mode of action of the device is as follows:–

After the mould has been filled, the machine controls provide a signal, as a result of which the voltage source 12 is connected to the mould halves 1 and 2, in such a way that the negative pole of the voltage source 12 is in connection with the mould half 2. Because of the resulting electrophoresis effect, the mould can be opened after a few hundredths of a second, with the moulding 4 releasing satisfactorily and easily from the mould 2. With the mould open and the moulding still held in mould half 1, the gripper 5 is now swivelled, or introduced, between the mould halves, to a position accurately centered relative to the moulding 4, and is placed with its contact surface 8 on the exposed surface of the moulding 4. At the same time, the machine controls produce a connection between the space 10 in the gripper 5 and the vacuum device 17, so that the contact surface 8 is sucked against the moulding 4. Simultaneously, or subsequently, the polarity of the connections of the voltage source 12 reversed and the contact surface 8 is connected in place of the mould half 2, so that the mould half 1 is in connection with the negative pole of the voltage source 12 whilst the contact surface 8 is connected to the positive pole. As a result, the moulding 4 is released from the mould half 1, so that on retracting the gripper 5 the moulding 4 adheres firmly to the contact surface 8 and can be set down by the gripper 5 on a plaster of Paris mould or on a drying table or

conveyor belt, as desired and depending on the moisture content of the moulding. The setting-down process can be assisted by the space 10 of the gripper 5 being connected with the compressed air source 18, so that the moulding 4 is actively forced off the contact surface 8. The stream of compressed air which flows through the channels 9 at the same time cleans the pores or channels of water and any material remnants which may be present.

The switch-over sequence described above, by means of which the electrophoresis is in each case effected at the correct surfaces, result from the following positions of the contact-actuating components a to d of the change-over switch 13:–

Before the opening of the mould, the contact-actuating components b and c are energised, so that the corresponding contacts are closed, whilst the contact-actuating components a and d remain at rest as illustrated. As a result, the electrophoretic action occurs at the mould half 2, which is connected to the positive pole so that the mould can be opened after a few moments (see the representation in the drawing).

To exert electrophoresis on the contact surface 8, the contact-actuating components a and d of the changeover switch 13 energised whilst the contacts of contact-actuating components b and c are brought into the open position. In this event, the positive pole is connected to the contact surface. A third possible setting of the circuit, not essential in the present context, is to keep the contact-actuating components a and b open whilst the contact-actuating components c and d attract. As a result, the electrophoresis process is exerted at the mould half 1.

CLAIMS

1. A device for removing ceramic mouldings from an injection moulding machine having two mould halves, such device comprising a gripper and means to move the gripper to and from a position in which it can engage a moulding in one of the mould halves when the mould is opened, the gripper having an air permeable contact surface of an electrically conductive material shaped matchingly to engage at least part of the exposed surface of such a moulding, and including means to apply suction through the contact surface and means to connect a direct-voltage source across the contact surface and said one mould half.

2. A device according to claim 1, wherein the contact surface of the gripper is a surface of a piece of metallic sintered material.

3. A device according to claim 1, wherein the contact surface of the gripper is a surface of a perforated metal plate.

4. A device according to claim 1, 2 or 3, including means to apply compessed air through the contact surface.

5. A device according to any one of the preceding claims, wherein the contact surface is on a part of the gripper which is replaceably fixed to a gripper body.

6. A device according to any preceding claim, wherein the means to connect the direct-voltage source includes switch means whereby the voltage source may be connected, alternatively, across the two mould halves and the polarity of application of the voltage source can be reversed.

7. A device according to any preceding claim including a direct-voltage source and a suction source.

8. A device for removing ceramic mouldings from an injection moulding machine, such device being substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

9. An injection moulding machine equipped with a device according to any preceding claim.

10. A method of removing ceramic moulding from an injection moulding machine including the steps of applying a gripper having an air permeable contact surface of conductive material against at least part of the exposed surface of a moulding held in one mould half upon opening of a mould, applying suction to the contact surface and applying a voltage across the contact surface and one mould half.

11. A method according to claim 10, including the further step of applying a voltage across both mould halves as they are opened.

12. A method of removing a ceramic moulding from an injection machine substantially as hereinbefore described.

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